AUSTRALIA

Form 10

PATENTS ACT 1952–1973

COMPLETE SPECIFICATION

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Complete Specification for the invention entitled:

The following statement is a full description of this invention, including the best method of performing it known to me:—*

*Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 160 mm in width, on tough white paper of good quality and it is to be inserted inside this form.

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FORM 10

Regulation 13(2)

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1973

COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:-

"IMPROVEMENTS IN AND RELATING TO PLUNGER TYPE PUMPS"

The following statement is a full description of this invention, including the best method of performing it known to us:-

THIS INVENTION relates to improvements in and relating to plunger type pumps, particularly but not solely for operation by windmills for raising water from bores and wells and from surface water supplies, and it has more particular reference to vertically reciprocable double-acting plunger pumps.

While the broad ideas involved in earlier pumps of the aforementioned types will meet the requirements for which such pumps have been devised, the present invention is also concerned with modifications thereof and improvements in order that the most efficient practical pump constructions may be produced and in order to cater for differing pumping requirements and types of installations.

The invention has as an object the provision of a vertically disposable plunger type pump which can be made to deliver water in approximately equal volumes on both the downward and the upward movements of the pump plunger, and in so doing greatly reducing the starting load, and the operating loads, on the prime mover by comparison with single-acting plunger pumps of the same size.

A further object is the provision of a double-acting pump in which the "up" and the "down" stroke loads counter-balance each other, and from which the discharge is continuous.

Another object of the invention is the provision of such pumps in the largest diameters which can be practically installed inside standard sizes of bore casings, but which may be made in any desired size.

Considering firstly a current standard type of deep well plunger pump which has a vertically slideable plunger operating within a pump barrel secured to the lower end of a delivery pipe, the pump being suspended in the body of the liquid to be pumped, or within a practical suction elevation thereabove. The plunger is connected to a suitable pumprod adapted to be reciprocated within the delivery pipe by means of a windmill or other source of power. The plunger is provided with a non-return upward or delivery valve and a non-return inlet valve is provided in the bottom of the pump chamber. Such pump assemblies both take in and deliver water only on upward movement of the pump plunger and no delivery or intake is performed on the downward movement. These movements are commonly referred to as the "up stroke" and the "down stroke", and will be so called in the following statements.

The total load on the prime mover motivating such pumps consists of a column of water equal in cross-sectional areato the cross-sectional area of the plunger (or displacer) and of a height equal to the pumping head, plus seal friction and flow friction. On up stroke operations the weight of the pumprods must be added, together with the intake load.

But the intake load is not a factor on the down stroke, while the weight of the pumprods becomes a positive force assisting the prime mover on the down stroke.

Such pump assemblies are very inefficient, particularly when operated by windmills, because the

entire column of water supported by the pump plunger, plus the intake load and the weight of the pump rods, must be raised to the limit of the stroke length on every up stroke. Because the entire product of an intake operation of the pump must be delivered only on each up stroke, large and expensive delivery pipes must be provided in order to avoid the imposition of excessive flow friction loads.

Furthermore, the friction of the sliding seals required to sustain such heavy loads of water is much greater than is the case when lighter water loads are imposed upon the seals, as in pumps made according to my invention.

Such conventional pump assemblies require large and expensive windmills to operate them because of the high starting loads, which must be overcome at the beginning of each up stroke, due to the fact that the water load comes to rest at the top of each up stroke, and the entire load must be restarted at the beginning of each cycle of operation.

As windmills depend entirely upon air currents for their motive power and the preponderance of winds are light and fluctuating in districts where windmill pumped water is of greatest importance, it is most necessary to have windmills as lightly loaded as possible for easy starting, and as evenly loaded as possible to achieve the fullest measure of harmonic movement and maximum production of pumped water. Such windmills are also governed to guard against overspeed, which can cause

the plunger to move upward faster than inflow of water so that an air space is formed between the top surface of the incoming water and the lower face of the plunger. When the upward movement of the plunger is reversed, the plunger slams down against the spaced face of the water,and if the speed is excessive, this action can cause damage to the pump and pumprods.

The present invention aims to reduce the starting load on the prime mover, and to evenly distribute the operating loads so that the windmill may do productive work smoothly in the lightest breezes, and in so doing substantially reduce the damaging effects of intermittent loading on the working parts of the entire installation. Furthermore, the invention aims to provide a pump which will operate at higher speeds than can conventionally-made pumps without a loss of efficiency and/or sustaining damage.

As the lightest breezes are the most prevalent, this invention aims to permit many more hours of operation during any pumping period, as it will operate at more cycles per minute in all windspeeds than will single-acting pumps of the same size, thus greatly increasing water production.

With the foregoing and other objects in view, this invention resides broadly in a pump assembly including a piston assembly reciprocable within a pump chamber having a non-return inlet valve upstream of the piston assembly for inflow of liquid, and said piston assembly having a non-return discharge valve for

discharge therethrough of liquid from said pump chamber in a downstream direction through a passageway in a plunger operatively supporting said piston and passing sealably through an impervious transverse partition wall of said pump chamber, and connector means for operatively connecting said plunger to a pump rod or the like.

In order that the invention may be more readily understood and put into practical effect reference will now be made to the accompanying drawings which illustrate the preferred embodiments of the invention, and wherein:-

Fig. 1 is a cross-sectional view of a pump according to the present invention;

Fig. 2 is a diagrammatic view of the pump illustrating the down-stroke action;

Fig. 3 is a diagrammatic view of the pump showing the up-stroke operation; and

Fig. 4 is a diagrammatic view of an alternate form of the pump according to the invention.

As shown in Figs. 1 and 2, the basic pump construction comprises a cylindrical pump chamber 10 having ports 11 near its upper end for the relief of back pressure during the operation of the pump. These ports 11 may be screened against the intrusion of sand or other harmful matter. The pump chamber 10 is fitted with a bottom cap 12, which may be fitted with a suitable strainer 14 and which houses a non-return bottom valve

assembly 13, having a central opening for the inflow of water.

The upper end of the pump chamber 10 is fitted with a top cap 15 which forms a connection for the water delivery column 16, and it is provided internally with annular grooves into which are fitted "U" cup or other suitable flexible seals which slidably and sealably engage the outer surface of the reciprocating cylinder 17 mounted within chamber 10 and the lower end of which forms the plunger 9 supporting the piston 8. The piston 8 includes a non-return delivery valve assembly 18 having a control valve seat for inflow of water into the passage 7, and external annular grooves 19 in which are fitted "U" cups or other flexible seals which slidably and sealably engage the inner face of the pump chamber 10. The upper end of the reciprocating cylinder 17 protrudes above the top cap 15 into the delivery column 16 and is operatively connected to the pumprod 26, as by the screw-on connector 20 which seals the upper end of the cylinder 17. The latter is provided with discharge ports 21 spaced above the top cap 15, for the passage of water from the interior of the cylinder 17 into the delivery column 16, which forms a secondary pump chamber.

The upper end of the reciprocating cylinder 17 is provided with a sealably movable reciprocating member such as a diaphragm or as in this embodiment, a free piston 27, having annular grooves 22 fitted with "U" cup or other suitable seals which slidably engage

the inner surfaces of the air chamber 23 formed by the sealed upper portion of the cylinder 17. The piston 21 prevents intermingling of the pumped water with the air contained within the air chamber 23. Of course, the diameter of the air chamber need not be the same as that of the cylinder 17 and can be made as desired. A discharge tee 24 is fitted to the top end of the delivery column 16 and a spill piece and/or stuffing box as desired may be utilised for vertical discharge of the pumped water.

In operation, during the initial up stroke, the delivery valve assembly 18 closes, and the plunger's upward movement causes the bottom or intake valve assembly 13 to open and induce the entry of a full charge of water into the pump chamber 10 beneath the piston 8. On the initial downstroke, the bottom valve assembly 13 closes, and the full charge of water in the pump chamber 10 flows past the opened delivery valve 18, into the reciprocating cylinder 17, and as the latter is of smaller cross-sectional area than the pump chamber, approximately half of the water overflows through the ports 27 into the delivery column 16 above the top cap 15. On all up strokes, the intake function is repeated, and the intrusion of the reciprocating cylinder 17, which has a larger diameter than the pump rod 26, into the delivery column 16 displaces through the tee 24 a volume of water equal to the reduction in volume in the column 16.

On the down stroke, the volume of the column

16 is reduced by the retraction therefrom of the cylinder 17, but a full charge of water is supplied from the pump chamber 10. Thus, water is delivered on the down stroke equal to the volume of the pump chamber 10 minus the increase in volume of the delivery column 16. Thus, the delivery effort is split between the up stroke and the down stroke so that it is reduced for each stroke to enable a small starting torque to mobilise the pump and to provide continuous delivery.

The air chamber 23 with its contained free piston 27 constitutes a supplementary hydro-pneumatic piston type pump, which further evens out the outflow of water as the back pressure from the water in the delivery column forces the free piston to compress the air trapped above it in the air chamber. The degree of compression varies in accordance with the head of water in the column, and the rate of travel of the pump plunger. Maximum compression occurs with normal maximum output, but the latter is reduced to increase the output at the ends of the respective cycles. This again ensures a constant continuous outflow of pumped water from the outlet 24.

For example, as the plunger comes to rest at the end of each stroke so, too, do the columns of pumped water in other types of plunger pumps, but in the present invention as the plunger reaches its maximum rate of travel in mid-stroke the air in the air chamber is correspondingly compressed at that time, and as the plunger slows down approaching the end of its stroke, the stored energy in the compressed air forces the piston

downwards to keep the moving water flowing past the points of zero impulse from the pump plunger.

By these means, the air chamber adjusts the counter-balancing of the up and the down stroke loads and supplements the power from the prime mover from within the system's own power resources. It will be seen that the weight of the pump rod assists the down stroke and thus it assists in the delivery of water.

Furthermore, the inlet and outlet orifices of the valve assemblies may be disposed centrally about the axis of the pump cylinder in the end caps of the pump, thus providing minimum resistance to flow therethrough, and a common delivery passage through the pump is provided for the discharge of water on both the upward and the downward movements of the pump plunger. But of course, these features are not essential.

The invention provides a pump which is self priming and can operate against high heads in a single stage while maintaining the continuity of flow common to rotary pumps, which require greatly increased power inputs to deliver liquids against high heads through multiple stages. The elimination or substantial reduction of pulsation in the pumped water permits the usage of the cheaper grades of plastic pipes for delivery, a particular advantage where the water has to be pumped over long distances.

In Fig. 4, there is shown a pump according to the present invantion, arranged as a syphon pump. This pump 30 differs from the just described embodiment in that

a sealed primary chamber 31 is added about the lower end of the pump chamber 10a, and provided with an inlet 32.

As the head of water in the delivery column 16 is supported above the sealing cap 15, and not directly above the piston 8, the problem of overspeed causing damage to the pump is substantially reduced, so that the pump according to the present invention will, when driven by a windmill, deliver water at low wind speeds, due to its relative ease of starting and continue to deliver water at high wind speeds.

It will, of course, be realised that the particular preferred embodiments referred to herein are illustrative only and may be subject to many modifications of constructional detail and design as would be apparent to persons skilled in the art without departing from the scope and ambit of the invention as is defined in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A pump assembly including a piston assembly reciprocable within a pump chamber having a non-return inlet valve upstream of the piston assembly for inflow of liquid, and said piston assembly having a non-return discharge valve for discharge therethrough of liquid from said pump chamber in a downstream direction through a passageway in a plunger operatively supporting said piston and passing sealably through an impervious transverse partition wall of said pump chamber, and connector means for operatively connecting said plunger to a pumprod or the like.

2. A pump assembly according to claim 1, wherein said pump chamber is in the form of a vertically disposed pump cylinder and said plunger comprises a vertically disposed cylinder spaced inwardly and concentrically within said pump cylinder and passing sealably through a top cap constituting said partition wall, and there being provided a delivery column extending upwardly from said top cap and enclosing the upper end of said plunger, the latter being apertured adjacent its upper end for communication of its interior, which constitutes said passageway with said delivery column.

3. A pump assembly according to claim 1 or claim 2, wherein there is provided a sealed air chamber on said plunger and having a sealably-movable reciprocable member communicating with said passageway.

4. A pump assembly according to claim 3, wherein said air chamber comprises an air cylinder having a free

piston therein, the latter constituting said sealably movable reciprocable member.

5. A pump assembly according to claim 4, wherein said air cylinder is constituted by an extension of said passageway in said plunger.

6. A pump assembly according to any one of the preceding claims, wherein the said non-return discharge valve assembly has its valve seat disposed centrally on said piston.

7. A pump assembly according to any one of the preceding claims, wherein the ratio of the area of said piston to the cross-sectional area of said passageway is substantially 2:1.

8. A pump assembly according to any one of the preceding claims, wherein said pump assembly is adapted as a syphon pump and said pump chamber is housed within a priming chamber having an inlet for connection to a remote liquid source.

9. A pump assembly according to any one of the preceding claims and adapted to be submersed within a bore and actuated by means of a windmill or the like.

10. A pump assembly substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 22nd day of February, 1977.

MAX LANSELL STAER and DEAN LANSELL STAER
By their Patent Attorneys
T.G. AHEARN & CO.

(T.G. Ahearn)
Fellow Institute of Patent Attorneys of Australia

FIG. 1.

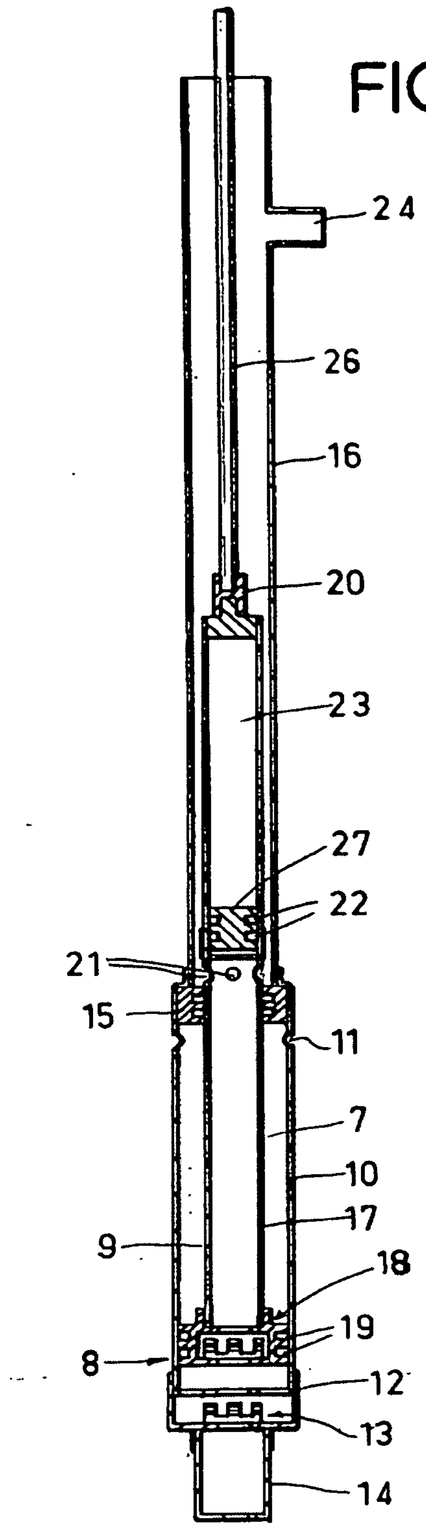
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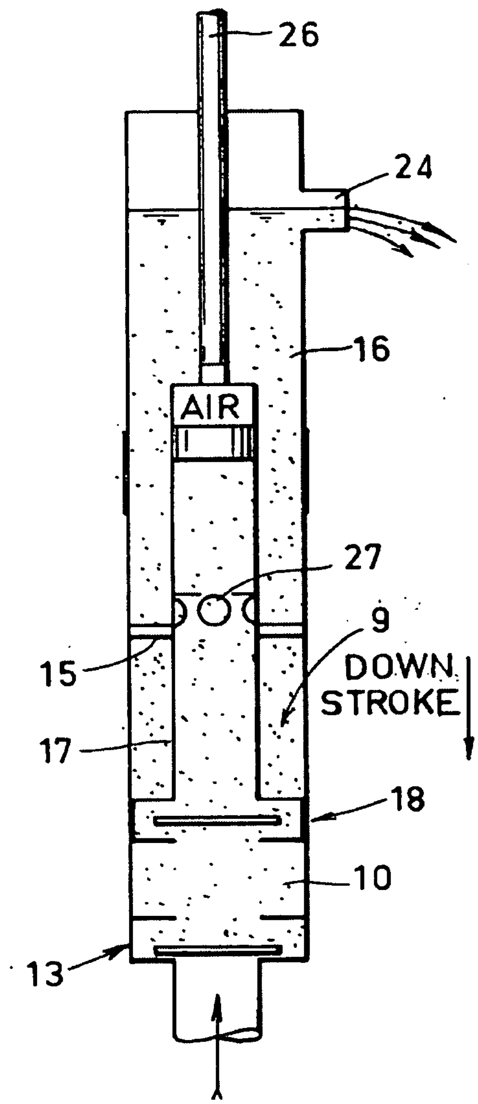
FIG. 2.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24
16
AIR
27
9
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13

FIG. 3.

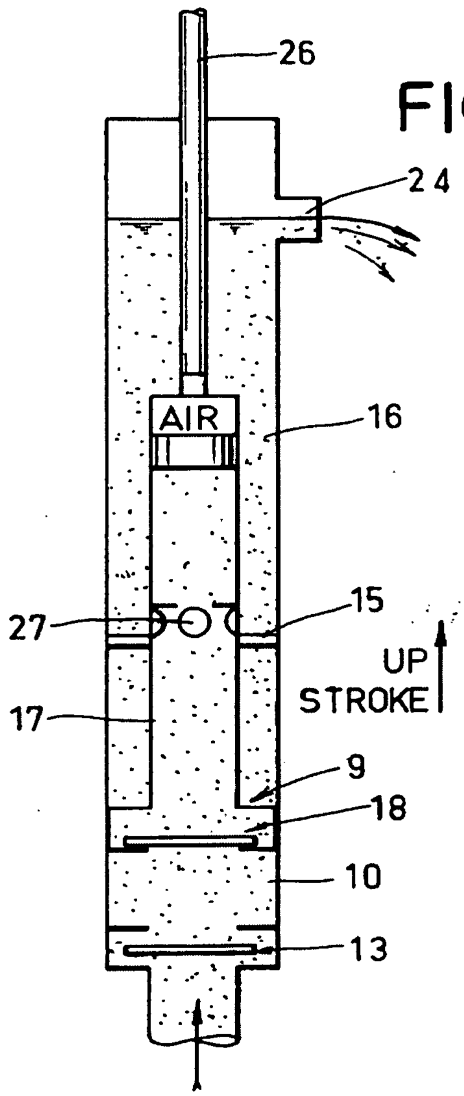

FIG. 4.